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RESEARCH PAPER

Effect of Ce^{3+} dopant ions on the shape and luminescence of $YPO_4:Eu^{3+}$ and $YPO_4:Tb^{3+}$ nanocrystals

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Abstract Nanoparticles of $YPO_4:Eu^{3+}$, $YPO_4:Eu^{3+}:Ce^{3+}$, $YPO_4:Tb^{3+}$, and $YPO_4:Ce^{3+}:Tb^{3+}$ with different amount of Eu^{3+} or Tb^{3+} dopant ions were synthesized by a hydrothermal route. Particle structures and morphologies were investigated and it was found that the increase of Eu^{3+} or Tb^{3+} ions, and co-doping with Ce^{3+} ions resulted in a transition of the crystal structure from tetragonal to hexagonal phase. The phase transition and the morphology transformation should be ascribed to the change of the average radius of cation by doping Ce^{3+}, or to the changing the amount of Eu^{3+} or Tb^{3+}. The energy transfer from Ce^{3+} ions to Eu^{3+} and Tb^{3+} ions was tested by studying the photoluminescence lifetime of $YPO_4:Eu^{3+}$, $YPO_4:Eu^{3+}:Ce^{3+}$, $YPO_4:Tb^{3+}$, and $YPO_4:Ce^{3+}:Tb^{3+}$ nanoparticles, and their energy transfer results in the improvement of the luminescence intensity. A schematic diagram for the electronic transitions of the studied systems is presented.

Keywords Optical materials and properties · Structure · Luminescence · Rare earth phosphates

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Introduction

Lanthanide nanoparticles have been of importance for their wide applications in high-performance magnets, luminescent devices, catalysts, and other functional materials (Liu et al. 2008; Luwang et al. 2010, 2011; Rodriguez-liviano et al. 2012). The multiple sharp emission peaks arising from *f* to *f* orbital electronic transitions make it possible to provide spectroscopic fingerprints. Among various lanthanide nanoparticles, rare earth phosphates have been extensively studied because of their high thermal, chemical, and mechanical stability. Nanostructured lanthanide phosphates are good hosts for the activator Ln^{3+} ions (Huo et al. 2007; Lehmann et al. 2003; Yu et al. 2009). In these studies, particle size, shape, and surface effects were found to significantly modify the luminescence properties such as the light absorption, lifetime of excited

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